

## REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

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1. AGENCY USE ONLY (Leave blank)			2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
				FINAL - 01 SEP 93 TO 30 SEP 96
4. TITLE AND SUBTITLE			5. FUNDING NUMBERS	
AASERT93/ THE MODELING OF HIGH-SPEED NONLINEAR OPTICAL COMMUNICATIONS			F49620-93-1-0485 61103D 3484/ZS	
6. AUTHOR(S)			AFOSR-TR-96	
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)			0508	
NORTHWESTERN UNIVERSITY 633 CLARK STREET EVANSTON IL 60208-1110				
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
AFOSR/NM 110 DUNCAN AVE, SUITE B115 BOLLING AFB DC 20332-8080			F49620-93-1-0485	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION AVAILABILITY STATEMENT			12b. DISTRIBUTION CODE	
APPROVED FOR PUBLIC RELEASE DISTRIBUTION UNLIMITED				
13. ABSTRACT (Maximum 200 words) SEE REPORT				
19961028 003				
14. SUBJECT TERMS			15. NUMBER OF PAGES	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT		18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED		UNCLASSIFIED	UNCLASSIFIED	SAR

To: Dianne Pierson@ngNM  
From: Arje Nachman@ngNM  
Originated by: Bill Kath <kath@asp.esam.nwu.edu>  
Cc:  
Bcc:  
Subject: fwd: AASERT Final Report

Attachment: 10/18/96 10:12 AM  
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Original text <kath@asp.esam.nwu.edu>, on 10/15/96 9:38 AM:  
From Bill Kath <kath@asp.esam.nwu.edu>  
To: "Arje Nachman" <arje.nachman@afosr.af.mil>

> The Sept report I require isn't meant to cover ASSERTS. Indeed the  
> latter is a legal subset of a regular grant. Since You'll be given an  
> extension til 15 Sept you might hold off sending me what you just sent  
> me until then and call it a Final.

Arje,

Here is the final report for the AASERT.

Best regards,

- Bill Kath

The Modeling of High-Speed Nonlinear Optical Communications

AFOSR FY93 AASERT Grant F49620-93-1-0485

Final Technical Report  
1 September 1993 - 31 September 1996

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OBJECTIVES

Ms. Anne Niculae has been studying the mathematical modeling of  
technologies which can facilitate high-bandwidth optical  
communications, specifically:

- o the modeling of novel phase-sensitive amplifiers (PSAs) for  
long-distance pulse propagation in nonlinear optical fibers

o the modeling of timing jitter in erbium-doped fibers lasers mode-locked by an input bit stream.

#### STATUS OF EFFORT

Ms. Niculae has developed a great deal of expertise concerning the modeling of pulse propagation in nonlinear optical fibers and related applications, such as erbium-doped fiber lasers. Her research is complete and she defended her thesis during September, 1996. She will remain at Northwestern during the 1996-1997 in a part-time teaching and research position. She has a number of publications which have either already appeared or will be submitted shortly, and has presented her work at a number of national and international meetings. Her efforts have begun to break new ground in a number of areas (particularly in the modeling of timing jitter in erbium-doped fiber lasers), and it is planned that research in these areas will continue in the coming year.

#### ACCOMPLISHMENTS/NEW FINDINGS

High-speed optical pulse propagation in nonlinear optical fibers is governed by the nonlinear Schrödinger (NLS) equation, which describes how the fiber's dispersion is compensated by the self-phase modulation induced by the nonlinearity; the result is pulses which nominally propagate without change of shape, called solitons. Perturbations can destroy solitons or their ability to carry information errorlessly, however, so that in many cases controlling of optical solitons to reduce the effect of the perturbations becomes necessary. We have been exploring the use of phase-sensitive amplifiers (PSAs) to provide such control.

Ms. Niculae has examined the case where feedback techniques are used to set the PSA phase, which is a more realistic model of the real experimental situation. Ms. Niculae has shown that PSAs retain the majority of their controlling behavior in this case, thus further demonstrating that the remaining hurdles to a successful implementation of a PSA-based device are more of a technical nature, rather than a conceptual one. More work still needs to be done, however, to determine if such devices can be made practicable.

Ms. Niculae has also begun studies of timing jitter reduction in an erbium-doped fiber laser mode-locked by an input bit stream, with good agreement between her analytical prediction and the numerical simulations. Such a laser (which has been built at British Telecom Labs) can be used to re-time an input signal as the front end of an all-optical switching device. Our desire is to improve the models to the point where they can provide significant a priori information about the performance characteristics of such devices.

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None

\* Post-Docs

None

\* Graduate Students

Ms. Anne Niculae

\* Other (please list role)

Mr. Arnold Kim (undergraduate research assistant)

#### PUBLICATIONS

\* SUBMITTED

\* Books/Book Chapters

\* Journals (to be submitted)

Timing jitter reduction in a laser mode-locked by an input bit-stream, to be submitted to Optics Letters (Anne Niculae and William L. Kath).

Analysis of pulse propagation in nonlinear optical fibers with phase-locked phase-sensitive amplifiers, to be submitted to SIAM J. on Applied Mathematics (Anne Niculae and William L. Kath).

\* Conferences

\* ACCEPTED

\* Books/Book Chapters

\* Journals

Stabilizing dark solitons by using periodic phase-sensitive amplification, Optics Letters, v. 21 (1996), pp. 465-476 (Arnold D. Kim, William L. Kath and Christopher G. Goedde).

Pulse propagation in nonlinear optical fibers with phase-locked phase-sensitive amplifiers, Optics Letters, v. 20 (1995), pp. 557-559 (Anne Niculae and William L. Kath).

\* Conferences (Refereed)

Timing jitter reduction in a laser mode-locked by an input bit-stream, Nonlinear Guided Wave Technical Digest, (1996) (Anne Niculae and William L. Kath).

#### INTERACTIONS/TRANSITIONS

\* Diffraction/Diffration + Modulation + Conformal Cominano

bit-stream, Nonlinear Guided Wave Conference, Cambridge, England, August, 1996.

Timing jitter reduction in a laser mode-locked by an input bit-stream, Workshop on Mathematical Methods in Nonlinear Optics, Basic Research Institute in the Mathematical Sciences, Hewlett-Packard Laboratories, Bristol, England, September 1996.

Soliton control in nonlinear optical fibers using parametric amplification, Workshop on Nonlinear Optics, Arizona Center for Mathematical Sciences, University of Arizona, Tucson, Arizona, October 1995.

Pulse propagation in nonlinear optical fibers with phase-locked phase-sensitive amplifiers, Conference on Applications of Dynamical Systems, sponsored by the Society for Industrial and Applied Mathematics, Snowbird, Utah, May 1995.

Pulse propagation in nonlinear optical fibers with phase-locked phase-sensitive amplifiers, Society for Industrial and Applied Mathematics Annual Meeting, San Diego, California, July 1994.

\* Consultative And Advisory Functions To Other Laboratories And Agencies

\* Transitions

NEW DISCOVERIES, INVENTIONS, OR PATENT DISCLOSURES

None.

HONORS/AWARDS